The profitability drivers in packaging materials reuse for manufacturers in business to business environments

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The profitability drivers in packaging materials reuse for manufacturers in business to business environments

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Abstract
Purpose –The purpose of this paper is to explore the profitability drivers for a firm's operation of a reverse supply chain (RSC) that takes back and reuses packaging materials. Results apply specifically to original equipment manufacturers (OEMs) in business to business environments.
Design/Methodology/Approach – Using in-depth data from the Danish manufacturer of measurement instruments, Radiometer Medical, the paper first identifies the total set of factors that directly influence the profitability of reusing packaging materials, and second assesses the relative impact among the identified factors. The paper's theoretical basis is the RSC literature's business perspective formulated by Guide and Van Wassenhove.
Findings – The drivers of profitability in packaging materials reuse are 1) the amount of avoided costs of purchasing new packaging materials, 2) the firm's ability to reduce costs of reverse logistics.
Research limitations/implications – The study's data is limited to one firm's operation in one country, which limits the generalizability of the paper's findings. However, the paper provides the basis for examining the bilateral relationships between the identified drivers and reuse profitability as well as between the drivers and their sub-level antecedents.
Originality/value – The study provides exploratory insights into the economics of reusing packaging materials and identifies the drivers that are decisive for a firm's ability to reuse packaging materials profitably.

Keywords: Reverse logistics; reverse supply chain; packaging materials, profitability; original equipment manufacturer; case study research

Paper type: Research paper within thesis

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1. Introduction

The prevalent concept of the reverse supply chain (RSC) by Guide and Van Wassenhove (2002, 2009) describes the RSC as five connected processes as depicted in Figure 1. The concept encompasses the whole end-to-end RSC and views the RSC as a flow beginning (as well as ending) with the customer. The RSC begins with acquiring used products from the market. Used products are labeled "core products" in RSC literature. When core products are acquired, the RSC physically moves them to an inspection and sorting facility through reverse logistics. Here the RSC inspects core products to determine the most appropriate recovery or disposal stream (examples are direct reuse, refurbishing, component salvage, or incineration). Recovery operations may include disassembly, cleaning, exchange of worn components, reassembly, and testing procedures. Finally, the RSC remarkets recovered products to either primary or secondary markets. An alternative end-destination for recovered items is internal reuse, for example as spare-parts in the firms servicing of their installed base of products.

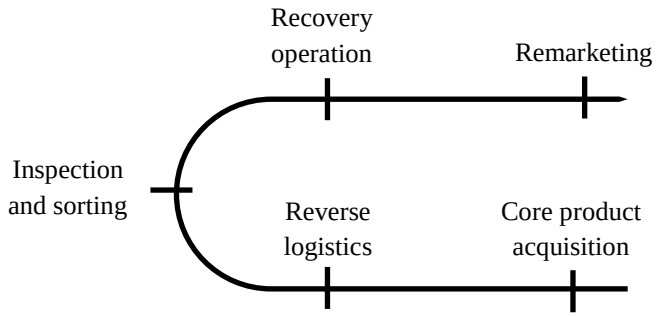

Figure 1- The reverse supply chain (Guide and Van Wassenhove, 2002)

Over the past two decades the industrial use of RSCs as well as the academic interest in the topic has increased (Rubio *et al.* 2008; Ilgin and Gupta, 2010). There are several reasons for this development: 1) increasing raw material prices makes reuse attractive, 2) "green" consumer segments are willing to pay premiums for sustainability in manufacturing, 3) RSCs can contribute to competitive advantages, and 4) in some industries regulations force firms to comply with extended producer responsibilities that include materials recycling (Klausner and Hendrickson, 2000; Stock *et al.*, 2002; Ginsberg and Bloom, 2004; Geyer *et al.*, 2007; Atasu *et al,*. 2008; Guide and Van Wassenhove, 2009). However, a recent review of RSC literature by Huscroft *et al.* (2013) concludes that investigating ways to establish the RSC as a profit center in the organization is one of the greatest current needs for scholarly research with the RSC field. The Confederation of Danish Industry (DI) supports this research challenge by reporting that low profitability is one of the greatest barriers for RSC implementation and operation (Tronhus, 2010).

Under-explored in literature is the set of profitability drivers for operating RSCs. To establish the RSC as an independent profit-creating entity in the organization, managers need a better understanding of what these drivers are. If managers are familiar with the set of drivers, they have an early and strong indicator of whether RSC-implementation in their particular firm will result in profits or losses. In addition, familiarity with profitability drivers focuses managers' attention to the real barriers for creating profits through their RSC.

Several papers have examined individual factors influencing RSC-profitability. For example, the cost of reverse logistics (Krikke *et al.*, 2008) and the cost of acquiring core products (Guide and Van Wassenhove, 2001). Common for much RSC-research is a focus on cost reduction. A newer perspective on the RSC has, however, emerged since the mid-2000s. This perspective, labelled the business perspective on the RSC, is looking at the RSC as a potentially profitable business

proposition (Guide and Van Wassenhove, 2006, 2009). The major difference from the earlier cost reduction perspective is that this literature views the RSC as a value creator rather than a nuisance or necessary evil that should be conducted for lowest possible cost.

The set of items that a RSC can take back and reuse can be categorized as follows: 1) commercial returns, which are products the customer is free to return within a specified period (e.g. 60 or 90 days); end-of-use returns, e.g. a copy machine taken back at the end of a lease period; end-of-life returns, which are products that are worn to an irreparable state, and distribution returns, which concerns packaging materials that can be taken back and reused. The latter is in focus of this paper and the purpose of the paper is to contribute to the RSC literature viewing the RSC through a business perspective by answering the following research question: What are the drivers of profitability specifically in reuse of packaging materials?

The study is explorative in nature and provides a basis for future research, where the relationship between each identified driver in this study and the financial performance of the RSC can be investigated further. Drivers of profitability in packaging materials reuse are currently under-explored in operations management (OM) literature. A search in academic literature using the search string "packaging AND reuse AND profit" yields between 20 and 30 hits of which none are within OM literature. The 20 to 30 papers address a large variety of issues, for example plastics waste reduction and evaluations of packaging material type (e.g. PET vs. glass).

The remainder of the paper is organized as follows. Sections 2 and 3 limit the study's domain and review extant literature on influencing factors of RSC-profitability. Section 4 details the study's research method. Sections 5 and 6 describe and analyze the selected case, and present findings. Sections 7 and 8 discuss findings, provide conclusions, and suggestions for further research.

2. Domain limitation

The paper's findings will apply to original equipment manufacturers (OEMs), which the paper defines roughly as follows: The firm manufactures end-products, components for servicing these products, and consumables that are consumes by the equipment when operating. The firm delivers their products, which are used as part of customers' manufacturing system and not as components in their products, directly to their customers without intermediaries. For the remainder of the paper this type of firm is labelled "the focal firm".

The paper uses in-depth data from the medium-sized Danish manufacturer of measurement instruments Radiometer Medical, which technically limits the study's findings to firms that participate in the measurement instrument manufacturing industry. However, the unit of analysis is the economics of reusing packaging materials, which are not idiosyncratic to firms in this particular industry. Diving into one specific industry for insights is supported by Carter and Easton (2011), who mention deep dives in to individual industries as future research opportunities.

The paper distinguishes between direct influencers of RSC-profitability and sub-level antecedents to these direct influencers. Direct influencers are factors that would typically be part of quantitative cost-benefit analyses. Examples are 1) the cost of disassembling a core product and 2) the cost of acquiring core products from customers. Direct influencers are undoubtedly influenced by sub-level antecedents, which may be the real causes of low RSC-profitability. For example, a sub-level antecedent for the direct influencer *cost of disassembling a core product* is *the ease of disassembly* which in turn depends on the original *method of assembly*. The pathway to uncovering the presumably all-important sub-level antecedents goes through the identification of direct influencers. We limit the study to examine direct influencers leaving the study of antecedents for future research.

3. Literature review

The overall theoretical frame for the paper's analysis is Guide and Van Wassenhove's business perspective on the RSC (Guide and Van Wassenhove, 2006). In this perspective the major question is how the RSC can provide the firm with value, rather than how the firm can reduce the costs of their RSC. Figure 2, which represents our interpretation of the crux of the business perspective on the RSC, illustrates the difference between the two RSC literature streams.

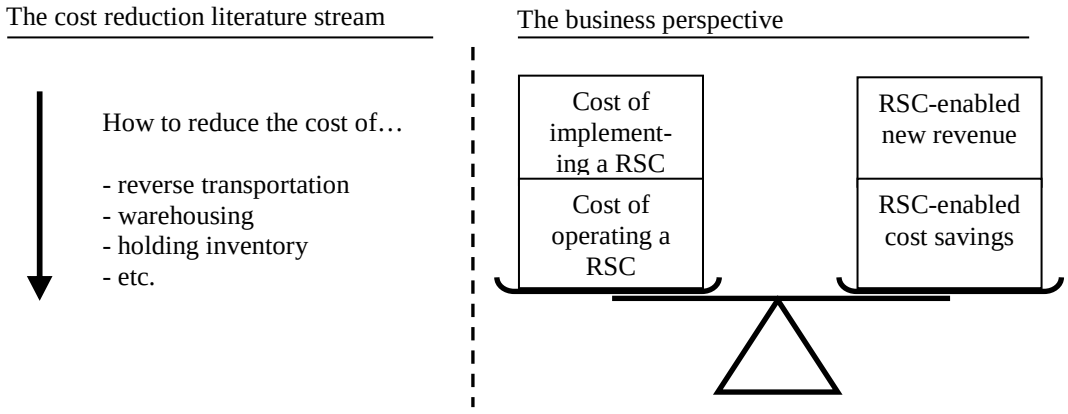

Figure 2 – The cost reduction literature stream and the business perspective on the RSC

The purpose of this review is to identify the content of the four boxes in the right-hand side of Figure 2. The content of each box is a set of direct influencers of RSC-profitability in packaging materials reuse. The formula below, which views the RSC as an independent profit center, captures the essence of the figure in a mathematical expression.

$$RSC\ profit = (revenues + cost\ savings) - (implementation\ costs + operating\ costs)$$

The study defines a direct influencer as "a monetary flow to or from the firm created by the RSC". These flows are either in- or outgoing. The study considers the most influential direct influencers as the *drivers of profitability* in packaging materials reuse and it is the purpose of the paper to identify these.

Outgoing monetary flows: Following the RSC-concept of Guide and Van Wassenhove the first outgoing monetary flow created by the RSC is the cost of acquiring core items from the market (e.g. Guide and Jayaraman, 2000; Guide and Van Wassenhove, 2001; Geyer et al., 2007). Packaging materials may have value to the customer if items can be sold to third parties in which case the focal firm needs to cover customers' loss of revenue from reselling used packaging materials.

When the focal firm has acquired items from customers, these items are transported to a sorting facility through reverse logistics. Reverse logistics is the most examined term in the RSC literature. Examples of literature reviews that cover reverse logistics are Sasikumar and Kannan (2008) and Pohkarel and Mutha (2009). The cost of reverse logistics depends on the OEM's specific set-up, but does include physical collection costs, long-haul transport costs, materials handling, and holding inventory.

At the firm's facility items are inspected and sorted according to their quality. High quality items can be recovered, while worn items are scrapped. The subject has received limited attention in literature. Examples are Galbreth and Blackburn (2006), who examine the optimal degree of selectivity when sorting, and Robotis et al. (2012), who investigate inspection capabilities. For

packaging materials the process is simpler than for complex products. Complex products need special skills and equipment for testing and failure identification. For packaging materials inventory personnel can make decisions rather easy.

Theirry *et al.* (1995) list a set of recovery options. Recovery of packaging materials is comprised of the activities cleaning and materials handling. Disassembly, exchange of worn components, and test procedures (Larsen and Jacobsen, 2014) are not necessary. However, the cost of disposal (Geyer et al., 2007) of those materials that cannot be reused directly impacts profitability. There are no described implementation costs particularly for operating a packaging materials reuse RSC in extant literature.

Ingoing monetary flows: Larsen and Jacobsen (2015) list eight possible cost savings in the firm's forward supply chain of which two apply to packaging materials reuse: 1) Replacing the cost of purchasing virgin components[2] and 2) reducing landfill costs. While replacing the purchase of virgin packaging materials is a direct influencer on the focal firm's profitability, landfill costs are paid by the customer (if they are not taken back by the focal firm). However, if the focal takes back packaging materials customers are relieved from this expense, which may make the focal firm able to charge a marginally higher price for their product, i.e. increase their revenue, which may constitute a direct influencer.

The set of in- and outgoing monetary flows identified in the literature review are applied in the case study.

4. Research method – single case study

The study applies a single case study to examine the research question. We have selected case study research as it enables examination of focused phenomena using contextually rich data from real-world settings (Barrat *et al.*, 2011). In addition, case research enables investigation of actual practice and a deep understanding of the complexity and nature of phenomena under examination (Meredith, 1989; Voss *et al.*, 2002). The following sections delineate the paper's data collection and analysis methods.

Data collection: The theoretical frame, which is developed from extant literature, consists of the set of direct influencers relevant for calculating the profitability of packaging materials reuse (i.e. the content of the four boxes on the right-hand side of Figure 2). The case study will identify and quantify each direct influencer in the case firm. To do so the study uses 1) interviews with supply chain and sales personnel to understand the case firm's supply chain and possible reuse practices, and 2) quantitative data to calculate each direct influencer. Furthermore, the case study will be used to identify any direct influencers relevant for calculating the profits from packaging materials reuse missing in extant literature.

Data analysis: First, the paper describes the case under examination; second, using the set of direct influencers identified in the paper's literature review, the paper calculates the average monthly profit (or loss) from reusing packaging materials; third, the paper conducts sensitivity analysis on the monthly profit. In the sensitivity analysis each direct influencer is increased by 20% while

[2] Larsen and Jacobsen (2014) distinguish between three items that the RSC can process: 1) complete end-products, 2) components, and 3) materials. The difference between a component and a material is whether the shape and functionality of the item is kept during the recovery process. The shape and functionality of a packaging material is kept and therefore a packaging material is considered a component (in spite of its name). A major difference between the components that constitute the product and packaging materials is that packaging materials reach their end-of-use when the product is unpacked, while the product's constituent components last until the product itself is at its end-of-life.

observing the impact on the monthly profit. The expected outcome of the sensitivity analysis is a Pareto distribution over the direct influencers' impact. Those direct influencers that have the greatest impact are identified as the drivers of profitability in packaging materials reuse.

5. Case description

The case firm is the Danish manufacturer of measurement instruments Radiometer Medical. The firm produces and delivers instruments, components (for use as spare parts), and consumables that are at set of liquids that instruments use when conducting measurements. The analysis examines the financial difference between two scenarios that are analyzed using data from the firm's deliveries to the German market during 2014.

Scenario 1: The firm purchases new packaging materials for every shipment and these packaging materials are disposed of by the customer through their waste stream at the customer's expense.

Scenario 2: The firm takes back, cleans and reuses all packaging materials from the market to the firm's factory. Those packaging materials that are not reusable are scrapped at the factory and new packaging materials are purchased for replacement.

Scenario 1 is the current situation with the case firm. Numbers relevant for Scenario 2 are either collected from internal firm departments (e.g. the cost of purchasing new packaging materials is collected from the purchasing department) or from third parties (e.g. the cost of reverse logistics is received as an offer from a third party logistics provider).

6. Case analysis and findings

As delineated in the section on research method, the case analysis first calculates the monthly profits from reusing packaging materials and then evaluates each direct influencer's relative impact on profitability.

Scenario 1: The 2014 the firm shipped 12,408 deliveries to the German market. The total monthly purchasing cost of packaging materials for all deliveries is € 18,851. This number represents the cost of Scenario 1. The focal firm pays for all materials and has no responsibility for these materials once delivered to customers.

Scenario 2, incoming monetary flows: The firm's supply chain department estimates a reusability rate of 90%, so nine out of ten materials replace the purchase of a new material leading to a monthly cost saving of € 17,183. Although several interviewees in the firm's supply chain department including the firm's global supply chain director mentioned customers' irritation with handling and disposing of packaging materials, the sales division does not believe that the firm can charge a marginally higher price for taking back packaging materials. Instead they worry that customers will become aware of their costs of handling and disposing of packaging materials and demand take-back without compensation. In the analysis added revenue from relieving customers from handling and disposing of materials are set at € 0.

Scenario 2, outgoing monetary flows: The monthly reverse logistics costs for take back and delivery from customer's to the firm's factory is € 6,166 monthly and the internal cost of handling materials, sorting, and recovering are estimated at € 1.110 per month. Costs of disposing non-reusable materials are € 167 per month.

Using the formula presented in the literature review, the potential RSC-profit resulting from packaging materials reuse is € 9.740 per month. To this amount the firm could add any possible revenue from offering customers the service of taking back packaging materials. The next part of the analysis will conduct sensitivity analysis of each variable to determine which has most impact on profitability. Each variable is increased by 20%. For each increase the impact on monthly profit is observed. Figure 3 shows the set of influencers on the abscissa and the impact on profitability on the ordinate. The impact numbers are denoted as absolute numbers in the figure. The figure shows that the top two influencers of the profitability of packaging materials reuse are 1) The reduced costs of purchasing and 2) reverse logistics costs. From these two influencers we conclude that the drivers of profitability in packaging materials reuse are: 1) the amount of avoided costs of purchasing new packaging materials that reuse enable, and 2) the firm's ability to reduce costs of reverse transportation.

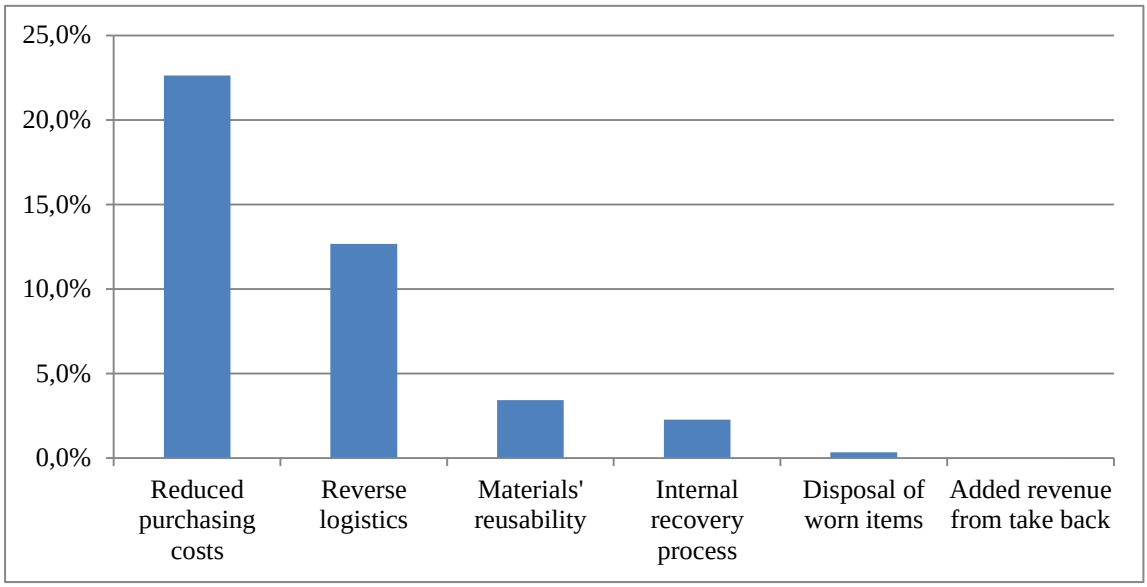

Figure 3 – The impact of each monetary direct influencer on the profitability of packaging materials reuse

7. Discussion

In principle packaging materials flow through the same set of RSC-processes as end-products and components, but most processes include reduced complexity. For example, inspecting the quality and sorting items into a either reuse or disposal streams can be conducted by inventory personnel without much training. The same applies to the recovery process, which mostly concerns cleaning the materials sorted for reuse. Extant literature in the OM domain has not (yet) examined the profitability drivers of packaging materials reuse, perhaps because of the limited complexity compared to products and components.

8. Conclusion

The drivers of profitability in packaging materials reuse are 1) the amount of avoided costs of purchasing new packaging materials that reuse enable, and 2) the firm's ability to reduce costs of reverse transportation. Additional influencers of profitability include the firm's internal cost of handling, sorting, and cleaning packaging materials, as well as the firm's costs of disposing non-reusable materials.

8.1 Suggestions for further research

The study represents a first dive into the subject of profitability in packaging materials reuse and offers ample opportunities for further research. Among these are:

- Testing whether the two identified factors are *the* drivers of profitability in packaging materials reuse, e.g. in different industries and regions
- Examining the bilateral relationship between each profitability driver and the profitability of reusing packaging materials
- Identifying the sub-level antecedents for the two profitability drivers. Examples are 1) the relationship between transport distances and the costs of reverse logistics, and 2) the impact of reduced quantity discounts for purchasing new packaging materials in lower quantities volumes in the reuse scenario
- Investigating whether take-back is sellable as a service to customers that can result in in higher revenues
- Examine different take-back network designs (e.g. sorting materials prior to acquisition)
- Examine the effect of different packaging materials solutions (e.g. wrapping cardboard around boxes to increase their reusability rate)

Reverse logistics network design is among the most researched fields in the RSC literature field. Examples are Jayaraman *et al.* (2003) and Krikke *et al.* (2008). But these do not concern packaging materials.

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